mimicry of which has been described by M. de Varigny in the 'Revue Scientifique'*; it appears to me that this is probably the case, as also in *Portumnus variegatus*, which disappears almost completely upon coarse granitic sand, as I have myself been able to observe. Be that as it may, we see from these examples that concealment by isochromatic adaptation seems to be a very widely spread fact in the different orders of Crustacea, and that albinism in these animals appears to be only a particular case of a very much more general phenomenon of chromatic adaptation to the medium.

XVIII.—*Observations upon* Amœba, *with especial reference to the existence of an apparent Micro-nucleus in that Organism.* (Preliminary Communication.) By John E. S. Moore, A.R.C.S. (from the Huxley Research Laboratory, R. Coll. Sci. Lond.).

[Plate XII.]

Through the laborious investigations of Maupas, Bütschli, Hertwig, and others we are to-day pretty well acquainted with the minute structural peculiarities and life-history of the ciliate Protozoa. Regarded in the light of single cells these little beings present points of structure at once both strikingly different and similar to those apparent in the cells that build up the Metazoan tissues.

The karyokinetic division of the micro-nucleus ("Nebenkern," "endoplastule," "nucleolus") in the ciliate Infusoria is undoubtedly strictly comparable, step by step, with the similar process apparent in the cells of higher forms; but the coexistence of this structure itself with the macro-nucleus, which divides akinetically, is something totally unlike those conditions which ordinarily present themselves in Metazoan cells.

Our knowledge of the multitude of structures included under the somewhat comprehensive title of "Nebenkern" in the Metazoa is still in a sufficiently unedifying condition to render it impossible to say whether those remarkable bodies met with in the gland-cells of many animals, *i. e.* in the cells actively secreting, are normal or parasitic, or whether in such cells we may not have to deal with a third structure besides the

* de Varigny, 'Revue Scientifique,' 3e série, t. x. p. 92, 2e sem., 1885.

nucleus and attraction sphere, which may well retain the name of "Nebenkern"*.

In May last I succeeded in adducing evidence in support of the view, first initiated by Flemming I believe, that the karyokinetic division of a cell is in reality an expression of two metamorphoses, each to a certain extent independent of the other †: one affects the attraction-sphere and the dividing central bodies, the other the nucleus and the dividing chromosomes. And it is probable that this apparent duality in the metamorphosis may have had much to do with the modern conception that the protozoan micro-nucleus is more or less equivalent to the metazoan central body, and the metazoan chromatic element to the protozoan macro-nucleus ‡.

I am not of this opinion, for I fail to see how a structure presenting all the features of a karyokinetic division, such as is seen in the micro-nucleus of a *Paramœcium* or a *Colpidium*, can be compared with the central body of a cell, metazoan or other.

That the great macro-nucleus, where it exists in the Infusoria, is intimately related in some way or other to the digestive activity of the animal seems highly probable. Indeed it is difficult to see what other functions could be assigned to it; and the Ciliate as a single cell will have to perform all those secretive operations which in more highly specialized organisms would be told off to particular glandular organs §.

Thus it becomes possible that the existence of the "Nebenkern" in many gland-cells of the Metazoa (if that structure can be shown to be there normal) may offer an analogy to that differentiation of the nuclear elements apparent in the ciliate Infusoria. Whatever be the ultimate solution of

* See "Contributions to Morphol. and Physiol. of the Cell," Macallum, Trans. Canadian Institute, vol. i. pt. 2; Steinhaus, "Ueber parasitäre Einschlüsse in den Pancreaszellen der Amphibien," Ziegler's Beiträge zur Path. Anat. und zur Allgem. Path. Bd. vii. p. 367; Nussbaum, "Ueber den Bau und die Thätigkeit der Drüsen," Arch. für mikr. Anat. Bd. xxi. p. 296.

† Unpublished paper in the hands of the editor Quart. Journ. Micr. Sci.

‡ *Cf.* H. E. Ziegler, 'Biologisches Centralblatt,' Bd. xi. nos. 12 and 13, pp. 372–389; and Bütschli, "Ueber die sog. Centralkörper der Zelle und ihre Bedeutung," Verhandl. d. Naturhist.-med. Vereins zu Heidelberg, Bd. iv.

§ This view receives some support from a consideration of the multinucleate parasite *Opalina*. Here, where there is no need for digestive activity, as the animal is immersed in already digested food-material, we find a corresponding simplification of the nuclear elements, *all* of which present the micro-nuclear karyokinetically dividing structure.

these problems, it would be interesting to find anything comparable to such nuclear differentiation in the other Protozoa.

Turning to the Rhizopods, we find a great variety of nuclear conditions; for example, those described by Gruber in a compendious summary published in the 'Zeitschrift für wissenschaftliche Zoologie' *, and, again, in his 'Studien über Amöben' †, where there is an admirable description of the mono- and multinucleate forms of Amœbæ, of the great diffused nucleus of *A. proteus*, and of the numerous vesiculate nuclei of *Pelomyxa*.

The most interesting thing, however, about these nuclei seems to be the fact that whereas the multinuclei of *Pelomyxa* divide by a process equivalent to karyokinesis, the great diffused nucleus of *A. proteus*, according to the beautiful figures of Schulze and others, divides akinetically in the strictest sense of the term. So also the primary division of the nuclear element in *Arcella*, when nearing the spore-forming stage, is typically karyokinetic; but whether this process of multiplication is maintained is not apparent.

The numerous nuclear elements in the Heliozoa appear, according to Gruber, to increase in a mitotic fashion, while the duplication of the nuclei in *Euglypha alveolata* is represented as proceeding by more than one method.

In an interesting paper in the 'Zeitschrift für wissenschaftliche Zoologie' ‡ Verworn describes in *Difflugia lobostoma* the conjugation process and the existence of corpuscles answering to the micro-nuclei of the Ciliata. Of these structures he says:—"Neben den Individuen, welche die obenbeschriebenen normalen Kernverhältnisse zeigten, fanden sich sehr häufig auch einzelne lebende Exemplare mit ganz abweichendem Verhalten. Diese Individuen besassen zwar auch den grossen runden, blassen Kern, mit ganz normalem Aussehen . . . ausser ihm noch einen zweiten, der eine völlig verschiedene Beschaffenheit aufwies;" and further, "Öfter fand ich Konjugationen, in denen, ausser dem normalen grossen Kern, keine kleine Kerne vorhanden waren." He sums up thus: "Dass der Kern eine bedeutsame Rolle bei der Konjugation spielt, indem die Konjugation charakterisirt ist durch das Auftreten je eines kleinen eigenthümlich gestalteten Kerns neben dem gewöhnlichen, der möglicherweise dem Nebenkern der Ciliata Infusorien entspricht, und ferner dadurch, dass diese kleine Kerne der beiden Individuen während der Konjugation in nahe Beziehung zu einander treten."

* Bd. xl. 1884, pp. 121–152.

† "Eine Mittheilung über Kernvermehrung und Schwärmerbildung bei Süsswasser-Rhizopoden," *ibid.* Bd. liii. 1892, pp. 114–118.

‡ Bd. l. 1891, p. 443, Taf. 18.

From these observations it becomes probable that we shall have to deal, as Verworn himself says, with such bodies related to conjugation in other Rhizopods. At the same time it is probable that the further study of the apparent discrepancies in the nuclear division of these animals may hereafter lead up to very interesting conclusions, with respect to a possible periodicity in the occurrence of direct and indirect division in such forms of life.

Mr. Lister has kindly sent me, through Prof. Howes, the MS. of a paper read before the Linnean Society of London*, in which he demonstrates the very important fact that in the Mycetozoa the numerous nuclei in the streaming plasmodia divide directly till just before the formation of the spores, when the division passes into typical karyokinesis.

Of the life-history of the Rhizopods we know in reality very little, and it seems to me highly probable that much of the apparent confusion with respect to their direct and indirect division may be due to a possible periodicity in their recurrence.

During the examination of some Amœbæ last autumn I became struck with the regularity in appearance and persistence of a small granular body, usually near the nuclear element, and in its general relationships very like a micro-corpuscle during certain phases of its evolution (Pl. XII. fig. 1).

Although loath to enter into a description of a new structure where we have already descriptions and structures enough to last for half a century, I would state that this body appeared to those who saw it a definite entity, and that it showed a remarkable tendency, when displaced in the living animal by the pressure of the cover-glass or other means, to return eventually to its position beside the nucleus.

It did not stain with picro-carmine, but remained perfectly visible after fixing with either gold or platinum chloride (fig. 1); and it could be stained slightly with orange, as was the case with Verworn's corpuscle in *Difflugia*. Flemming's fluid rendered it nearly invisible, on account of the induced contraction; while no better results were obtained with either mercuric chloride or acetic acid. Indeed, it was much best seen when the animal was in full activity (figs. 2, 3).

Of both the significance and metamorphosis of this body I am absolutely ignorant; and my knowledge is summed up in the assertion that there is a small body of fairly constant appearance near the nuclei of some Amœbæ, and (as those

* Meeting held December 1st. *Cf.* reports in scientific journals.

originally observed were of large size, and as I have not found it in smaller broods since examined) that it possibly only occurs in certain conditions of activity of the same *.

Respecting the other bodies and granules apparent in Amœbæ I have a few remarks to offer.

Exclusive of matter obviously indigestible, which is rapidly extruded, it appears that the remaining granules may be grouped within three categories: one, containing all those fragments of undigested matter, some of whose original characters remain, and two others of a totally different appearance, viz. a second, containing all those spherical homogeneous globules, usually supposed to be fat (but, as the vast majority of them never blacken with osmic acid, this can hardly be the case), and a third, including the so-called crystalline bodies (concretions of Ray Lankester) †.

The origin and significance of the two latter remain still somewhat enigmatical. Considerable light, however, may be thrown on the inter-relations of the bodies in question if an active Amœba be ruptured under the weight of the cover-glass (which, if the animal be surrounded by clear water, usually occurs in from ten to fifteen minutes). If the issuing matter as well as that remaining, now relieved of pressure, be watched under a high power, not only are the more conspicuous masses of little-digested material seen to be surrounded with the usual vacuoles of ingestion, but a vast number of other vacuoles make their appearance, of all sizes, down to one just sufficient to include the smallest apparent concretions (fig. 9). Both the spherical globules and the so-called crystalline bodies are seen to occupy small vacuoles and to issue with them into the surrounding water.

During the later stages of digestion many fragments of nutritious matter bear a closer and closer resemblance to these globules, and it is possible to arrange complete series extending (i.) from the undigested food on the one hand to the homogeneous spheroids on the other (figs. 4–8), and (ii.) from these to the so-called crystalline bodies, which are not doubly refractive (fig. 10). As Miss Greenwood has pointed out ‡, the vacuoles about the food-material decrease up to a certain point; and they are, as she thought possible, secondarily acquired.

From these observations it seems that the food, after what

* It is probable that a body figured by Leidy in his monograph on the Rhizopods (plate v. fig. 8) is identical with that herein referred to.

† Quart. Journ. Micr. Sci. vol. xix. p. 484.

‡ 'Journal of Physiology,' vol. viii. pp. 264, 283.

we may call the primary process of digestion, enters into the condition of the spherical globules, each surrounded by its vacuole; and that these spheroids, gradually decreasing in size, are ultimately worked up into the so-called crystals *.

To the further consideration of this and other questions raised I intend to return at length.

EXPLANATION OF PLATE XII.

Fig. 1. Amœba after treatment with gold chloride. *a*, refractive body (? micro-nucleus).
Fig. 2. Living Amœba. *a*, refractive body.
Fig. 3. Nucleus of living Amœba, showing its relation to the refractive body (*a*) when at rest.
Figs. 4-6. Digesting matter in successive stages.
Figs. 7, 8. Homogeneous spheroids contained in vacuoles.
Fig. 9. Concretionary matters in relation to the small vacuoles.
Fig. 10. Relation between the spheroids and the so-called crystalline bodies.

Figs. 1 and 2 drawn under Zeiss's apochromatic system, oc. 8 compens. obj. 1·4 homog. immers. Figs. 3–10 drawn under same objective, with substitution of oc. 18.

XIX.—*On the probable Sensory Nature of the "Appendix" of the Antennæ of Coleopterous Larvæ.* By Charles J. Gahan, M.A., of the British Museum (Natural History).

Many Coleopterous larvæ are provided with a remarkable structure which is situated upon the distal surface of the penultimate segment of the antennæ. Though this structure has been noticed by more than one writer on Coleopterous larvæ and has been described as an "appendix," an "appendicular joint," a "blunt tubercle," and in other terms, it does not seem to have attracted much attention. At least, no author, so far as I am aware, has attempted to describe its microscopical characters in detail.

Some observations that I have recently made upon the antennæ of the larva of *Pterostichus*—a genus of Carabidæ—have led me to believe that the so-called appendix is in reality a sensory organ. When the antennæ of this larva are examined under the microscope the appendix is seen as a tolerably conspicuous object projecting from the oblique outer (or posterior) surface of the distal extremity of the third segment, its transverse diameter being very little less than

* Le Dantec has shown the vacuolar fluid of several Protozoa to be acid ('Annales de l'Institut Pasteur,' 1890, pp. 776-791).